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THE IMPACT OF TECHNOLOGY ON COMMODITY MARKETS

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Introduction

There are complex linkages between the development of new technologies and the health of the primary commodities markets. The common impact of technological advances, however, has been lower commodity prices, either through increased output or reduced demand. This paper identifies some important technologies affecting both agricultural and mineral commodities and discusses some forthcoming structural changes in the commodity markets that may result from technology research already underway. 25X1

Despite three years of global economic recovery, LDC real earnings from commodity exports in 1985--the last year for which full data are available--stood 35 percent below their 1979 peak. This decline is largely the result of weak demand and high production, which led to chronically low prices. This was a natural result of the record-high commodity prices of the 1970s, which spurred commodity production and substitute development. In nearly every market, there have been advances in technologies that have softened commodity prices. In *agricultural*, the trend has been toward technology-driven increases in *supply*, while in the *minerals* markets new technologies have created a wide range of substitutes that have undercut *demand*. A good example is rubber, which is both an agricultural product and an industrial input: biotechnology is enhancing rubber crop output, while increased competition from synthetic rubber and advanced polymers is eroding demand. 25X1

The effect on Third World commodity producers has been severe. Despite their growing debt-service payments and rising prices of most manufactured imports, commodity-dependent LDCs must increase export *volumes* to combat declining world *prices*. The wealthier, more stable LDCs that can afford the more efficient production technologies have a clear advantage in this environment. Smaller producers using outmoded techniques and deteriorating equipment face both price and volume reductions. As a result, real per capita LDC commodity earnings, as well as earnings as a share of global GNP, are now below their levels of 15 years ago. 25X1

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Technology and Minerals

Technological advances are providing a growing array of substitutes for raw materials. Two forces have driven these developments. First, the rapid commodity price increases of the 1970s raised the costs of most raw material inputs, which encouraged manufacturers to reduce the mineral content of their products. This was especially true in the auto industry where a premium was put on lightweight, fuel-efficient vehicles. Second, the natural progression of technological capabilities have created means by which certain finished-good industries can multiply output by using non-mineral resources. The demand for tin and iron is being weakened by new manufacturing technologies that require, for example, less tin per unit of area tin-plated or less iron inventories per ton of milled steel.

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On the mineral supply side, the nature of technological advance has been *evolutionary* rather than revolutionary, and technology has been unable to reduce mining costs quickly enough to stem the growing use of substitutes. There are mining technologies that are changing producers' competitiveness, however. The major innovation now being adopted is heap-leaching--a fairly low-tech, low-cost, easily mastered method for extracting minerals from low-grade ores. In many areas, heap-leaching is making previously uneconomical mines profitable.

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Some Specific Impacts

Tin. Technological developments in the two largest markets for tin-- packaging and electronics--have sharply reduced the demand for tin ore. In packaging, plastics and paper products have substituted for many tin-plated containers, while improved tin-coating technologies have reduced the amount of tin required per area of tin plate. In electronics, which accounts for one-fifth of tin demand, microelectronic circuitry is replacing many devices that required tin soldering. Saturated demand in tin's other markets, namely construction and transportation in the developed West, will keep tin imports down despite the collapse of prices.

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Iron. The "design revolution" of steel-intensive goods has sharply eroded the market for iron inputs. The US auto industry, which consumes 17 percent of US steel, reduced the average steel content of cars by 700 pounds over the last decade, and the industry hopes to cut steel use by another 40 percent over the next few years. Improved plastics have played an important role in this trend. Overall, US plastics production is rising faster than GNP, and the plastics industry is already twice the size of the entire US metals industry. Moreover, new materials, particularly advanced ceramics and composites, promise to further erode steel demand. Much will depend, however, on renewed growth in demand from the currently depressed Third World markets--which could be driven by the diffusion of production technologies to LDC durable-goods manufacturers.

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Technology and Agriculture

Agricultural technologies are primarily supply oriented, though advances in crop breeding and disease resistance may generate organic or artificial substitute products. Agrotechnologies generally fall into three categories: the fruits of genetic engineering, improved farm management practices--primarily soil management and alternative cropping systems--and refinement of mechanical aids to production. In addition to the phenomenal increases possible with new technologies, the spread of more traditional cropping patterns and animal husbandry techniques will continue to boost overall LDC farm productivity.

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In tropical products, world production has been most affected by advances in pest control, plantations populated with high-yielding strains, and the development of substitutes which provide additional competition in already burdened markets. On the positive side, however, alternative uses have been found for processing by-products.

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Oilseed production has benefitted from breeding advances, while the most significant challenge is the growing abundance of substitute vegetable oils. Palm oil is the biggest success story--output has more than doubled since 1978 and the market has increased every year. Recent production advances are largely attributed to cloning and Malaysia's introduction of the Cameroon weevil to improve pollination. In addition, an edible cottonseed has been developed in China, providing yet another substitute for soybean oil in human and animal diets.

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These various advances have enabled some LDCs to join the ranks of agricultural exporters, while other major producers continue to expand production into already glutted markets. We expect to see further gains in farm productivity as LDC expenditures on research and agricultural extension increase. As the competition in agricultural trade accelerates in coming years, more efficient producers will succeed--in most cases through a combination of plentiful nartural resources and making use of the currently available agrotechnologies to effectively utilize them. LDCs like Brazil and Malaysia will gain an edge on their agricultural competitors by emphasizing the research, development, and widespread dissemination of agrotechnology.

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Some Specific Impacts

Coffee. According to trade reports, a new coffee variety derived from wild strains could yield up to 1.2 tons per hectare. If the 500,000 hectares of currently available land are planted with this strain, Ethiopian output could be tripled from the current 200,000 tons per year.

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Cocoa. Malaysian cocoa production and exports have responded well to research advances. Recent progress in cocoa research by tropical research institutes includes the development of five new high-yielding cocoa clones. Looking to the future, pesticides effective against the cocoa moth could have a dramatic impact on production in East Malaysia--which currently holds some 50 percent of Malaysia's total cocoa acreage.

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Rubber. Culture technology allows mass propagation of highest-yielding rubber specimens at low cost. Researchers can produce as many as 20,000 identical seedlings from a single high-yield parent in a matter of months. Plantation crops in Malaysia, Thailand, and Indonesia will benefit most from this technology. In addition to cloning, more sophisticated tapping and processing techniques have lowered Thai rubber production costs and improved quality. As a result, export revenues have more than doubled in the past five years. Despite these recent technical advances, natural rubber production has been eclipsed by synthetic rubber--especially since the collapse in petroleum prices and because of the failure of producers to bring output in line with demand.

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The Outlook: More Substitution and Lower Cost Production

The structural changes underway in the commodity markets as a result of technological developments are irreversible. Current agricultural technology is spreading fast throughout the Third World, and is not likely to slow. In minerals, the huge development costs for substitutes now on the market--such as fiber optics--have already been spent, so the market share of these substitutes is not likely to shrink. Moreover, these substitutes have proven to be far more efficient on an average-cost basis than traditional mineral inputs. The future augers for more of the same. In agriculture, ongoing research in genetics promises even more revolutionary increases in crop output, just as materials sciences breakthroughs are expanding the range of commodity substitutes.

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Minerals. Key areas of materials research are ceramics, polymers, composites, and advanced alloys. In each case, scientists are creating substances that have far superior performance characteristics than currently available raw materials. In ceramics, for example, researchers believe they are close to removing one of the last obstacles to the widespread use of ceramic parts in high-temperature, high-corrosion environments: brittleness. Experts predict auto and aircraft engines in the future may be largely ceramic, replacing iron-based steel and bauxite-based aluminum. Composite-structures technology will allow manufacturers to "tailor make" materials to performance specifications far beyond the capabilities of current raw commodities.

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On a more positive note for producers, mining engineers continue to make strides toward lowering exploration and extraction costs of traditional ores. Commercial satellites and new methods on on-site testing are uncovering previously unknown ore deposits, some of which can be economically mined even with falling metals prices. Finally, it should be noted that science's most important recent breakthrough--the raising of superconductor temperatures--does not necessary bode ill for metals producers: because superconductors still require some cooling, researchers expect to use copper and aluminum pipes filled with liquid nitrogen and coated with superconducting material as the backbone of certain superconductor devices.

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Agriculture. While improvements in crop and animal management will continue to increase agricultural productivity, we expect the major breakthroughs in the next decade will come in the areas of mechanical advances, computer assisted production, and genetic engineering. The following technologies will probably be available by the year 2000.

- *Mechanical* advances will probably include surge-flow irrigation systems with an anticipated water savings of 50 percent over traditional flood irrigation. Low energy precision application (LEPA) systems and laser leveling of land will also permit more effective water usage.

- *Computer assisted production* will include the technology to guide robots via television cameras and computer scanning to harvest fruits and vegetables. In livestock production, computerized confinement systems will have the capability to monitor and regulate food, waste, temperature, and stress levels and make adjustments to enhance production.

- *Genetic engineering* advances will include pesticide resistance, plant growth regulators, genetic manipulation to enhance plant photosynthesis, and the adjustment of bacteria within the rumen of grazing animals to improve their feed conversion ratios and lower costs.

While it is difficult to predict the future economic impact of agrotechnology, we believe the degree of effort and level of funding --even if only sustained at current rates--will profoundly affect the nature of crop and animal production in the 21st century.

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APPENDIX

Information Technology and Commodity Markets: Mixed Impact

Like many other industries, the commodity markets are being reshaped by the global information revolution. Computers, telecommunications, and remote-sensing technologies are lowering commodity production costs, while to a lesser degree accelerating the development of commodity substitutes. [redacted] 25X1

The use of small computers in the field has allowed producers to streamline production. In *mineral* production, for example, new personal computer software can analyze optimal mineral "hoisting" techniques for opening a mine shaft in less than 10 percent of the time it previously took--greatly reducing the chance of costly errors. In steel milling, start-to-finish computer controls are cutting labor costs and improving quality and speed. [redacted] 25X1

In *agriculture*, microcomputers can be used to determine cost-effective operating speeds for grain combines by balancing costs with crop-harvesting efficiency. Computerized systems are already streamlining agricultural processing in some LDCs. [redacted] 25X1

Satellites are an increasingly important element in both mineral and agricultural production. For example, field conditions can be monitored by sensors and tied in with satellite weather forecasts to aid in irrigation scheduling. India's first remote sensing satellite reportedly was to be be launched from a Soviet space vehicle in June 1987. The Indian-built satellite is designed to monitor crop and forest inventories. The so-called IRS-1 will reportedly be the first in a series of satellites to be launched at intervals of about two years to form the backbone of India's National Natural Resources Management System. Future uses of the system will include mapping of watersheds, sedimentation patterns, and the condition of wheat and rice crops. In addition, improved computer programs now enable such systems to locate previously unidentifible geologic deposits of mineral ore. [redacted] 25X1

Information technology is also having a negative effect on commodity producers because of the computer's ability to design mineral substitutes for commodity consumers. For example, the use of computers in the auto industry has facilitated the design of lighter, less mineral-intensive auto bodies. Often cited as the main obstacle to replacing conventional metals with high-tech ceramics in engines and turbines is the lack of design experience for ceramic parts. Computer aided design (CAD), however, is

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shortening the time required to develop and test new ceramics and hastening the demise of metal parts in high-temperature devices. In another example, greatly enhanced inventory control as a result of computer accounting has been a major reason why companies keep far lower stocks of raw inputs than they did prior to the 1981 recession a procedure known as the *kanban* ("just in time") inventory strategy.

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